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## CHANGE IN THE CLIMATE OF KANSAS.

By F. H. SNOW, University of Kansas, Lawrence.

IN reiteration of his statements before the congressional committee regarding the subject of a change of climate in the region which includes the states of Kansas and Nebraska, Dr. Willis L. Moore, chief of the United States Weather Bureau, has issued a pamphlet. Among these statements I note the following: "We find, right in the arid regions, that during a long period of observations, thirty, forty or fifty years, the average rainfall of the first ten years is precisely the same as the average of the last." Yet, in the tabular statement which concludes Doctor Moore's pamphlet, only the last thirty years are included, although the records of three of the stations named cover respectively forty-eight, thirty-nine and forty-one years. I submit that a fair comparison of facts bearing upon so important a subject as the change of climate should include the entire period of observation.

My own records at Lawrence cover a period of thirty-nine years, from 1868 to 1906. During the first ten years of this period, from 1868 to 1877, the average annual rainfall was 34.91 inches; during the last ten years, 1897 to 1906, it was 38.16 inches, giving an increase of 3.25 inches per annum. But a more satisfactory method of comparison is to divide the entire period of observation into two equal parts. The total rainfall at Lawrence for the first half of the thirty-nine years, from January 1, 1868, to July 1, 1887, was 672.81 inches, while during the second half of the period the total was 743.67 inches, giving an increase of 70.86 inches in the total precipitation. This makes the average annual rainfall for the first half of the period 34.50 inches, while for the second half it is 38.14 inches, an increase of 3.64 inches, or more than ten per cent. And this is the result, although the rainfall at Lawrence for the year 1906 was only 28.50 inches—more than 8 inches below the average for the thirty-eight preceding years. This notable deficiency for 1906 occurred in the eastern portion of the region west of the ninety-fifth meridian, in which region Doctor Moore says that the rainfall for 1906 was excessive in all that vast stretch of territory.

Notwithstanding the facts brought out by my own observations, which have been regularly forwarded to the chief of the Weather Bureau, at Washington, at the end of each month and year, Doctor Moore states that "the rainfall has neither increased nor diminished

by amounts worthy of consideration." This statement, however, may be considered correct with regard to the western third of Kansas and Nebraska, as shown by the records of Dodge and North Platte; but it is not correct in regard to the eastern and central portions of those states, where the breaking and cultivation of the soil upon a large scale and the great increase of forestation have combined to produce conditions favorable to an increased rainfall. In the western portions of Kansas and Nebraska the conditions are practically the same to-day as they were in the eastern portions of those states when settlement first began.

There never has been a better opportunity to test the question of the effect of the sudden human occupation of an agricultural region upon climatic conditions than has been afforded in eastern and central Kansas and Nebraska during the last fifty years. Three millions of people now occupy this agricultural region, where fifty years ago the entire area was unplowed prairie. When I came to Kansas, in 1866, to begin my life-work as a member of the faculty of the State University, the only timber consisted of a narrow belt along each stream; and during the late autumn and winter I often counted at night as many as fifty to seventy simultaneous prairie-fires from my study windows in the University buildings, on the summit of Mount Oread. At that time by daylight, from the same point of view, every house in the city of Lawrence was plainly visible from foundation to roof, while at the present time the buildings, although greatly increased in number, are completely concealed from view by the foliage of the multitudinous shade-trees. The surrounding country also has been so changed in appearance by the growth of trees under human direction as no longer to bear the remotest resemblance to the original prairie surface.

Not only has the rainfall increased, but the atmospheric humidity has also increased. The average relative humidity for the first half of the period of my observations was 68.76 per cent., while during the second half it had risen to 73.21 per cent. When I came to Kansas, in 1866, and for several years thereafter, no dew was deposited upon the grass until toward morning, and one could walk through the grass at any time before midnight without wetting one's shoes. Of late years, the dew generally begins to be deposited on the grass before the twilight is over, as in the Eastern states, thus corroborating the observed increase in the atmospheric humidity.

In regard to the velocity of the wind, Doctor Moore, in his hearing before the congressional committee, stated that he was quite

certain that there had been no change in the general high velocity, for an altitude of 50, 60 or 100 feet, although the trees would restrict the velocity of the wind near the ground. In his pamphlet just issued he states that "an examination of the wind records in Kansas and Nebraska show that the last fifteen years have not been quite so windy as the fifteen years previous, but that it is not safe to assume that a permanent decrease in the wind velocity has taken place." My own records of the wind velocity began on July 1, 1872, when an excellent recording apparatus was installed upon the roof of the north dome of the main building of the University of Kansas, 105 feet above the ground, the ground itself being 250 feet above the broad valley of the Kansas river. This apparatus has been carefully kept in order under my personal direction during the entire  $34\frac{1}{2}$  years, and its results have been compared with, and corroborated by, those of a standard anemometer of the signal service pattern, which for fifteen years was in operation at the same elevation. If we adopt the method of comparison used by Doctor Moore in his rainfall statistics, and divide the thirty-four years into ten-year sections, we have the following results:

The average annual wind run of the first ten years (1873-'82) was 138,052 miles; of the second ten years (1883-'92), 131,040 miles; of the third ten years (1893-1902), 122,012 miles; of the last four years (1902-'06), 100,212 miles. But, as stated in regard to the rainfall, it seems to be a more satisfactory method of comparison to divide the entire period into two equal parts. By this method we find the average annual wind run of the first seventeen complete years (1873-'89), to be 134,389 miles, and of the second seventeen years (1890-1906), 119,252 miles. This gives an average reduction of 15,137 miles per annum for the second half of our period of observation as compared with the first half. Stated in another way, the average velocity of the wind for the first seventeen years was 15.34 miles an hour, while for the second seventeen years it was only 13.61 miles an hour, giving a reduction of nearly twelve per cent.

It thus appears that the observations of nearly forty years, made continuously by and under the direction of the writer, indicate a gradual change in the climate at Lawrence, Kan. And as this locality presents a typical illustration of the climatic conditions of eastern Kansas, it is safe to infer that the same changes are taking place over the entire region of which it forms a part. The rainfall and atmospheric humidity have increased, and the wind velocity has decreased. The change in the rainfall and wind

velocity has been in each case more than ten per cent., while the increase in the atmospheric humidity has been more than six per cent. And these results are based not “upon the recollections of the oldest inhabitants,” but upon the faithful records of actual observations.